

**M46-202 and M46-206
LINE PRINTER CONTROLLER
PROGRAMMING MANUAL**

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M46-202 and M46-206 LINE PRINTER CONTROLLER PROGRAMMING MANUAL

GENERAL DESCRIPTION

The M46-206 Line Printer Controller is designed to operate with a family of printers. These printers have a common interface specification differing only in print speed, power requirements, cabinet styling, and the arrangement of buttons on the Control Panel. INTERDATA part numbers have been assigned to two controllers for this family of printers, namely: M46-202 and M46-206. The M46-202 Line Printer Controller is designed to operate the Centronics Model 101 Line Printer and other equivalent printers capable of printing 60-200 LPM.

These Printers feature a full line (132 character) buffer, an 8 channel VFU (Vertical Format Unit). They print 64 characters per column according to the 7-bit ASCII code at 10 characters per inch. Line spacing is 6 lines per inch.

The Controller performs a modest amount of code conversion in order for the Controller/Printer combination to be compatible with existing INTERDATA test and driver programs. Characters may be loaded into the Printer Buffer via the Controller at speeds up to 200K bytes/second for the M46-206 and 75K bytes/second for the M46-202.

In the following sections, the definitions and procedures apply to both models of controllers. Refer to the Operators Manual, supplied with the Printer, for details on a specific model. Table 1 provides a cross-reference of the Line Printers to their respective Controllers by Marketing part number.

TABLE 1. LINE PRINTER TO CONTROLLER CROSS REFERENCE

LINE PRINTER	CONTROLLER	
MARKETING NUMBER	MARKETING NUMBER	PART NUMBER
M46-204 (200 LPM) M46-205 (200 LPM) (50 HZ VERSION)	M46-202 (7" BOARD)	02-244
M46-207 (200 LPM) M46-208 (200 LPM) (50 HZ VERSION) M46-209 (600 LPM) M46-210 (600 LPM) (50 HZ VERSION)	M46-206 (7" BOARD)	02-307

CONFIGURATION

The M46-206 and M46-202 Line Printer Controller and the associated Printer can be installed on the Multiplexor Channel Bus or the Selector Channel Bus of any INTERDATA Processor. See the Section on Interrupts concerning priority on the I/O Bus.

OPERATING PROCEDURES

Control Panel Switches and Indicators

The following is a list of Control Panel Switches and Indicators and their descriptions.

	M46-204 AND M46-205 LINE PRINTERS	M46-207, M46-208, M46-209, AND M46-210 LINE PRINTERS
Power	ON/OFF - This latching switch/indicator turns power ON or OFF to the Printer. It lights in the ON position.	Power On-Indicating Switch. Depressing this switch turns ON primary power in the Printer and lights the switch indicator lamp. Power Off-Indicating Switch. Depressing this switch turns OFF primary power in the Printer and lights the switch indicator lamp.
On Line/ Off Line	SELECT - This latching switch/indicator turns the Printer ON Line or OFF Line. It lights in the SELECT (On-Line) position.	Run-Indicating Switch. Depressing this switch enables print commands and lights the switch indicator lamp. Stop-Indicating Switch. Depressing this switch inhibits print commands and lights the switch indicator lamp.
Paper Advance	Top Of Form - This momentary action switch causes the paper to be advanced to the top of forms punch on the built-in Vertical Forms Control tape reader.	Home-Switch. Depressing this switch sets the paper feeding system to the Home condition and each time this switch is depressed, one paper form length is advanced through the Printer mechanism. This switch can also be used to eject paper forms at the end of a run. This switch is operable only when the STOP indicator is lit. One-Line Switch. Depressing this switch advances the paper form through the Printer one line-at-a-time, each time the switch is depressed. The switch is operable only when the STOP indicator is lit. Slew-Switches. Depressing the Home and One Line Switches together advances the paper form through the printer mechanism at the paper slew rate of 27.5 inches/second as long as both switches are depressed. These switches are operable only when the STOP indicator is lit.
Paper Empty	Forms Override - This momentary action switch resets the Paper Empty condition and allows printing to continue even after a Paper Empty condition is sensed by the Printer. Paper Out - This indicator lights when a Paper Empty condition is sensed by the Printer. This condition is cleared by loading more paper in the Printer or by depressing the FORMS OVERRIDE switch. Forms Thickness Control - This is used to adjust the clearance between the platen and the face of the print head assembly according to the thickness of the paper being used. For this adjustment, refer to the Technical Manual supplied with each Printer.	Tractor Position Knobs. Rotation of these knobs moves the paper feed tractors sideways. Form Thickness Knobs. These graduated and detented knobs are rotated to adjust the spacing between the print drum and print hammers to accommodate different forms and ribbons.

NOTE

The numbers on the knobs do not refer to the number of parts in the form.

Character Align Lever. Used to advance or retard activation of the print hammers with respect to the position of the characters on the spinning print drums as they pass the print hammers.

Latch Lever. Used to latch and unlatch the yoke.

Alarm-Indicator. This indicator lamp is lit when any of several fault conditions exist. The fault conditions which can be corrected by the machine operator are:

- Yoke-Closed Interlock Switch not closed.
- Yoke-latched Interlock Switch not closed.
- Blown Motor Fuse

Alarms **Hardware Alarm** – This indicator lights if the printer’s printing head carriage travels beyond the right-most allowable margin. This happens only if a malfunction occurs within the Printer. The Hardware Alarm condition is cleared by resetting the Safety Limit switch (located at the right side of the Printer carriage assembly), and by depressing the SELECT switch. Note that repeated occurrence of a Hardware Alarm condition indicates a need for maintenance to be performed on the Printer.

Control Knobs/Levers **Paper Feed Lever** – This lever, located on the right top of the Printer, is used for rapidly feeding paper in the forward direction.

Paper Advance Knob – This knob, located on the left side of the Printer, is used to adjust the paper position (forward and backward) relative to the Vertical Forms Control punched tape.

Infinite-Form-Position Control. When the lever of this control is unlatched, the knob may be rotated to adjust the vertical position of the form, when the stop indicator is illuminated and the paper is stationary.

Vertical-Form-Position Lever. This lever is used to adjust the location in the vertical direction of the print line with respect to pre-printed forms, when the run indicator is lit and the paper is being indexed during normal printing operations.

Vertical Form Unit

The Printer is equipped with an eight-channel vertical forms control feature which uses standard one inch punched tape, 10 punches per inch, as the control element. The tape is inserted into a reader which is located on the left side of the Printer. The tape format is shown in Figure 1.

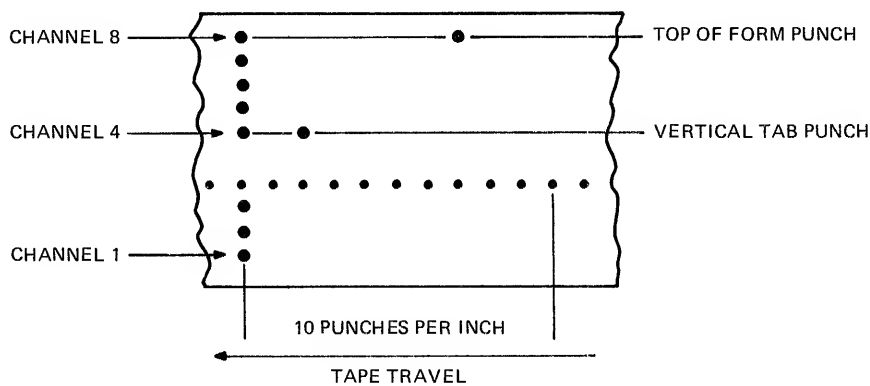


Figure 1. Tape Format

DATA FORMAT

The Controller transmits all upper case codes from X'20' to X'5E' to the Printer without conversion. Note that X'5E' prints as ^ (circumflex) and the code X'5F' (underline) is trapped and converted to X'3C' which prints as < (less than). All lower case codes, X'60' through X'7F', are converted and transmitted as X'40' through X'5F'. Note that the "underline" is printed when the Processor sends X'7F' to the Controller (M46-206) and that character X'7F' is treated as a Carriage Return (CR) in the M46-202 Controller.

M46-202 Controller

Non-printing codes X'00' through X'1F' are ignored with the following exceptions:

BELL (X'07')	This causes the Audio alarm to sound for approximately two seconds.
LF (X'0A')	This causes the paper to be advanced one line.
VT (X'0B')	This causes the paper to be advanced to Channel 5 of the vertical format tape.
FF (X'0C')	This causes the paper to be advanced to Channel 7 of the vertical format tape.
CR (X'0D')	This causes the Line Buffer to be printed, the print head carriage to be returned to the left margin, and the paper to be advanced one line.
SO (X'0E')	This causes the entire contents of the current line to be printed in expanded character size (0.20 inches center to center horizontally instead of 0.10 inches), allowing only 66 characters per line. The X'0E' character may be sent at any time in the course of loading the Line Buffer.

M46-206 Controller

Non-printing codes X'00' through X'1F' are undefined with the following exceptions:

LF (X'0A')	This causes the Line Buffer to be printed and the paper to be spaced one line, even if given after a Carriage Return (CR).
VT (X'0B')	This causes the Line Buffer to be printed and the paper to be spaced according to Channel 4 of the VFU tape, even if given after a CR.
FF (X'0C')	This causes the Line Buffer to be printed and the paper to be spaced according to Channel 8 of the VFU tape, even if given after a CR.
CR(X'0D')	This causes the Line Buffer to be printed. The paper is spaced according to the <i>next character</i> in the following manner:
X'01'	Single Space
X'0A'	Single Space
X'0B'	VFU Channel 4
X'0C'	VFU Channel 8
X'40' - X'77'	Space 00 to 55 lines
X'78' - X'7F'	Space according to VFU Channels 1 through 8.

If the character following CR is not part of the above list, the Controller sends the code for space 00 lines - i.e., no space. The next time the Line Buffer is printed, over printing occurs. This may or may not be deliberate.

The Carriage Return (CR) 01 sequence can be used with the 02-244 (M46-202) and the 02-307 (M46-206) Controller.

PROGRAMMING INSTRUCTIONS

Status and Command Bytes

Table 2 provides Status and Command Byte Information.

TABLE 2. LINE PRINTER CONTROLLER STATUS AND COMMAND BYTE DATA

BIT NUMBER	0	1	2	3	4	5	6	7
STATUS BYTE		PAPER EMPTY		*INTER-LOCK	BUSY	EX		DU
COMMAND BYTE	DISABLE	ENABLE						

DISARM
*M46-202 ONLY

STATUS

- PAPER EMPTY** This bit is set when the Paper Empty condition is activated in the Printer. This condition also sets the EX bit.
- INTERLOCK** This bit is set when the Printer carriage assembly overruns the allowable length of travel. This is a result of a hardware fault condition. This condition also sets the Busy bit.
- BUSY** This bit is set when the Interface is not ready to accept a character. It may be caused by a functional Printer operation or by the Interlock or Paper Empty condition. When this bit is reset, an interrupt is generated.
- EX** This bit is set when either the Paper Empty or Interlock bit is set.
- DU** This bit is set when the Printer is not selected (Off-Line), or if power is OFF. An interrupt is generated if this bit changes state in either direction.

COMMAND BYTE

- DISABLE** This bit set and ENABLE bit reset allows an interrupt to be queued without interrupting the Processor.
- ENABLE** This bit set and DISABLE bit reset allows the Interface to interrupt the Processor. (See INTERRUPTS).
- DISARM** With both DISABLE and ENABLE bits set, the interrupt system is DISARMED. Interrupts are not generated or queued.

INSTRUCTIONS

- OUTPUT COMMAND (OC or OCR)** The Interface may be Enabled, Disabled or Disarmed with this command.
- SENSE STATUS (SS or SSR)** This instruction returns status of the Controller.
- WRITE DATA (WD or WDR)
WRITE BLOCK (WB or WBR)** These instructions are used to output characters to the Printer and cause BUSY → 0.
- READ DATA (RD or RDR)** This instruction is ignored by the Printer.
- ACKNOWLEDGE INTERRUPT (AI or AIR)** If the Printer is Enabled, this instruction examines the Status bits when an interrupt is generated. This instruction is valid on 16-Bit Processor only.

PROGRAMMING SEQUENCES

The following is a brief description of different modes of operation. See 16-Bit and 32-Bit Reference Manuals, Publication Numbers 29-298 and 29-365, for general Programming Procedures.

Sense Status I/O Control

This form of I/O Programming uses loops to continually interrogate the status of a device until a specified condition is met. (See Appendix 2 and 3 for Programming Examples)

Interrupt I/O Control

16 Bit Processor

When using immediate interrupts on a 16 Bit Processor, the appropriate service pointer table must be set up to accommodate a PSW swap. Refer to Appendix 2 for a Programming Example.

32-Bit Processor

Interrupts are handled through the interrupt service pointer table (See Appendix 3 for Programming Example).

Auto Driver Channel I/O (32-Bit Processor Only)

The purpose of the Auto Driver Channel is to free the user from handling every interrupt. The Auto Driver Channel's function is controlled by the set up of the Channel Command Block. See Appendix 3 for Programming Examples.

INTERRUPTS

When interrupts are enabled, the Interface generates an interrupt when:

1. The Busy bit changes from ONE to ZERO.
2. The Paper Empty bit changes from ZERO to ONE.
3. The DÜ bit changes state in either direction.

NOTE

Since writing out a character causes Busy to change to ZERO, an efficient way to cause an interrupt is to write a null character.

NOTE

When the Line Printer is disabled, the interrupt is queued. When the Line Printer is disarmed, interrupts are not generated or queued.

NOTE

When running in an interrupt environment, the Line Printer, because of its rapid response, should be a lower priority than slower responding devices. If not, the Line Printer should be programmed via status loops with Processor interrupts enabled.

INITIALIZATION

When the Processor is initialized, the Line Printer Controller is disconnected from the Multiplexor Bus, the Busy status bit is reset, and interrupts are disarmed. The Printer is initialized (the Line Buffer reset) either by turning the power ON (ON/OFF switch) to the Printer, or by depressing the SELECT switch.

DEVICE NUMBER

The 02-307 or 02-244 preferred device number is X'62'. See the 16-Bit and 32-Bit Reference Manuals, Publication Numbers 29-398 and 29-365.

SAMPLE PROGRAMS AND FLOW CHARTS

Appendix 2 contains 2 Programming Examples for 16-Bit Processors. The first is a sample program and flowchart for all 16-Bit Processors to output a buffer of characters to the Printer using programmed Sense Status Loops.

The second is a sample program and flowchart for all 16-Bit Processors showing output to the Printer under Immediate Interrupt Control.

Appendix 3 contains three programming examples for 32-Bit Processors. The first is a sample program for all 32-Bit Processors to demonstrate output to the Printer using Sense Status Loops.

The second is a sample program and flowchart for all 32-Bit Processors to demonstrate output to the Printer under Interrupt Control.

The third is a sample program and flowchart for all 32-Bit Processors to demonstrate output to the Printer using the Auto Driver Channel.

APPENDIX 1
CHARACTER DEFINITION TABLE

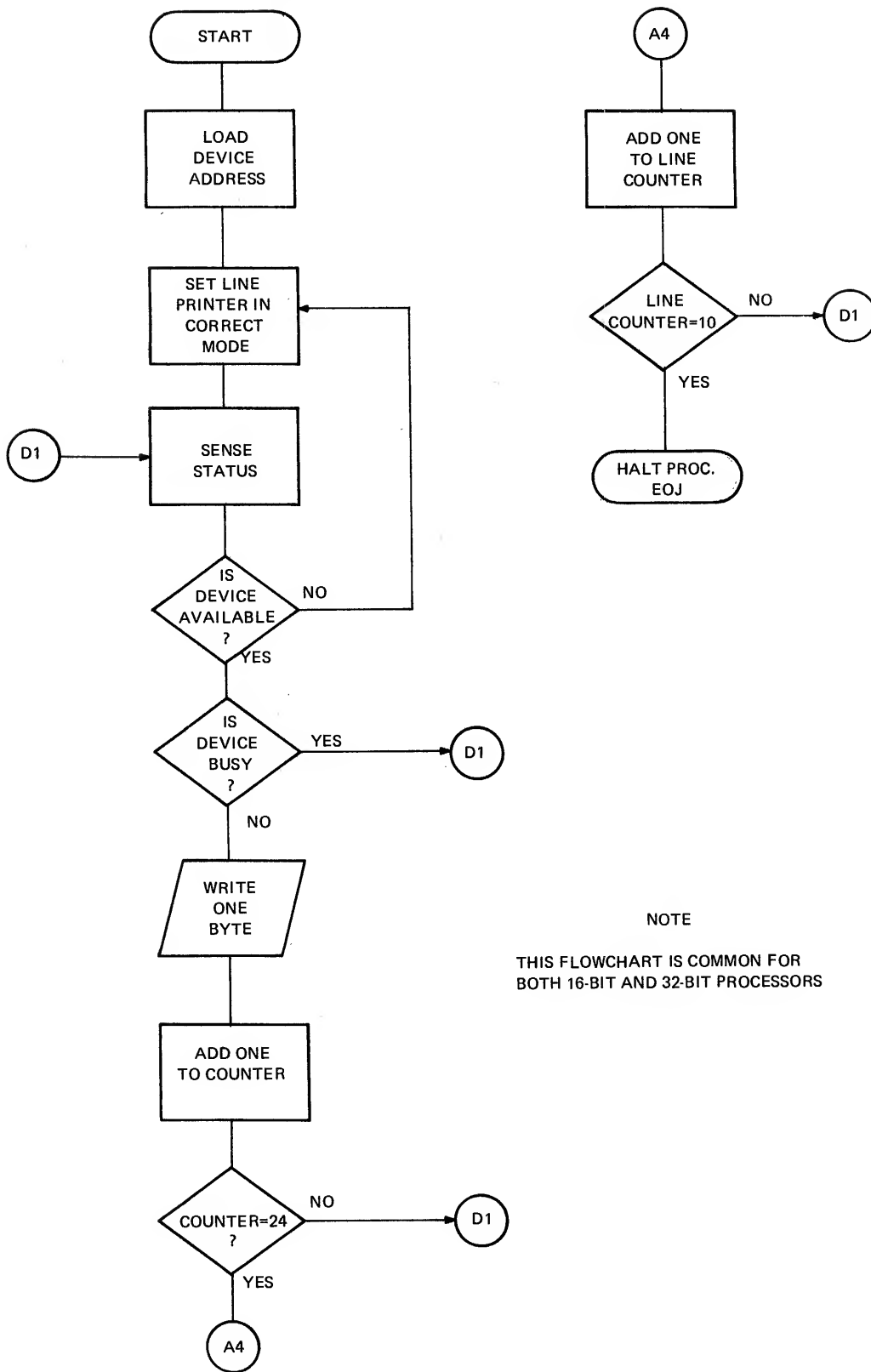
The following differences exist between all the printers.

<u>Printer</u>	<u>Character</u>	<u>Prints</u>
M46-204	5E	↑
M46-205	5E	↑
M46-207	5E	^
M46-208	5E	^
M46-209	5E	^
M46-210	5E	^
M46-204	5F	< (3C)
M46-205	5F	< (3C)
M46-207	5F	< (3C)
M46-208	5F	< (3C)
M46-209	5F	< (3C)
M46-210	5F	< (3C)
M46-204	7E	↑
M46-205	7E	↑
M46-207	7E	^
M46-208	7E	^
M46-209	7E	^
M46-210	7E	^
M46-204	7F	CR
M46-205	7F	CR
M46-207	7F	-
M46-208	7F	-
M46-209	7F	-
M46-210	7F	-

All Controllers convert X'60' thru X'7E' to X'40' thru X'5E'. M46-202 ignores all characters below X'20', and for the M46-206 all characters below X'20' are undefined.

<u>Printer</u>	<u>Character Given After (CR(OD)</u>	<u>Results</u>
M46-206	20-3F	Undefined
M46-206	40-77	Spaces 0 thru 55 lines
M46-206	78	Spaces to Channel 1
M46-206	79	Spaces to Channel 2
M46-206	7A	Spaces to Channel 3
M46-206	7B	Spaces to Channel 4
M46-206	7C	Spaces to Channel 5
M46-206	7D	Spaces to Channel 6
M46-206	7E	Spaces to Channel 7
M46-206	7F	Spaces to Channel 8
M46-206	01	Spaces 1 line
M46-202	01	Ignored
M46-206	LF(0A)	Causes buffer to print and space 1 line.
M46-202	LF(0A)	Causes paper to space 1 line.
M46-206	VT(0B)	Causes buffer to print and space to Channel 4.
M46-202	VT(0B)	Causes buffer to advance to Channel 5.
M46-206	FF(0C)	Causes buffer to print and space to Channel 8.
M46-202	FF(0C)	Causes paper to advance to Channel 7.
M46-206	CR(0D)	Causes buffer to print and advance on next character.
M46-202	CR(0D)	Causes buffer to print and space 1 line.

**APPENDIX 2
LINE PRINTER PROGRAMMING
EXAMPLES FOR 16-BIT PROCESSORS**



NOTE
THIS FLOWCHART IS COMMON FOR
BOTH 16-BIT AND 32-BIT PROCESSORS

SENSE STATUS LOOPS

PROG= LMPTR ASSEMBLED BY CAL 03-066R05-00 (32-BIT)

```

1 1 SCRAP
2 2 CROSS
3 3 WIDTH 120
4 4 TARGET 16
5 *
6 * SAMPLE PROGRAM FOR LINE PRINTER ON A 16-BIT PROCESSOR
7 *
8 * THIS PROGRAM UTILIZES SENSE STATUS LOOPS TO WRITE OUT A BUFFER,10X.
9 * THE BUFFER IS DEFINED AS ' LINE PRINTER 2.1 TEST,'
10 *
11 * SET UP REGISTERS
12 *
13 R1 EQU 1 DEVICE ADDRESS HOLD REGISTER
14 DU EQU 1 DEVICE UNAVAILABLE
15 R2 EQU 2 BUFFER LIMIT REGISTER
16 R3 EQU 3 STATUS HOLD REGISTER
17 R4 EQU 4 LINE COUNTER REGISTER
18 BSY EQU 8 BUSY
19 *
20 * LOAD DEVICE ADDRESS AND SET LINE PRINTER IN CORRECT MODE
21 *
22 START LH R1,LPADR LOAD DEVICE ADDRESS
23 XHR R2,R2 ZERO OUT REGISTER 2
24 XHR R4,R4 ZERO OUT REGISTER 4
25 OC OC R1,WRTCMD SET PRINTER IN WRITE MODE
26 *
27 * SENSE STATUS LOOP
28 *
29 SENSE SSR R1,R3 STATUS OF LINE PRINTER
30 BTBS DU,OC TEST FOR DEVICE UNAVAILABLE
31 BTBS BSY,SENSE TEST FOR BUSY STATUS
32 *
33 * FILL UP OUTPUT BUFFER
34 *
35 WD R1,BUFFER(R2) WRITE ONE BYTE FROM BUFFER
36 AIS R2,1 INCREMENT BUFFER
37 CLHI R2,24 IS BUFFER FILLED YET?
38 BE DONE YES, GO TO NEXT LINE
39 B SENSE NO, GO TO WRITE ANOTHER BYTE
40 *
41 * THIS ROUTINE COUNTS THE NUMBER OF LINES OUTPUT
42 *
43 DONE AIS R4,1 INCREMENT LINE COUNT
44 CLHI R4,10 ARE 10 LINES OUTPUT YET?
45 BE FINAL YES, GO TO END OF JOB
46 XHR R2,R2 ZERO OUT REGISTER 2
47 B SENSE GO TO WRITE ANOTHER BYTE
48 *
49 * DEFINE BUFFER AND OTHER CONSTANTS
50 *
51 BUFFER UC C' LINE PRINTER 2.1 TEST,'

```

APPENDIX 2 SENSE STATUS 16-BIT PROCESSORS

004AR 0001	52	DC	X'0D01'	OUTPUT CR AND SPACE 1 LINE
004CK 0062	53	DC	X'62'	LINE PRINTER ADDRESS
004ER 80	54	DB	X'80'	WRITE
0050R C200 0058R	55	LPSW	WAIT1	
** E002 **				
0056R	56	ALIGN	8	
0058R 8000	57	DCX	8000	
005AR 0050R	58	DC	A(FINAL)	PUT PROCESSOR IN FINAL WAIT STATE
005CR	59	END		

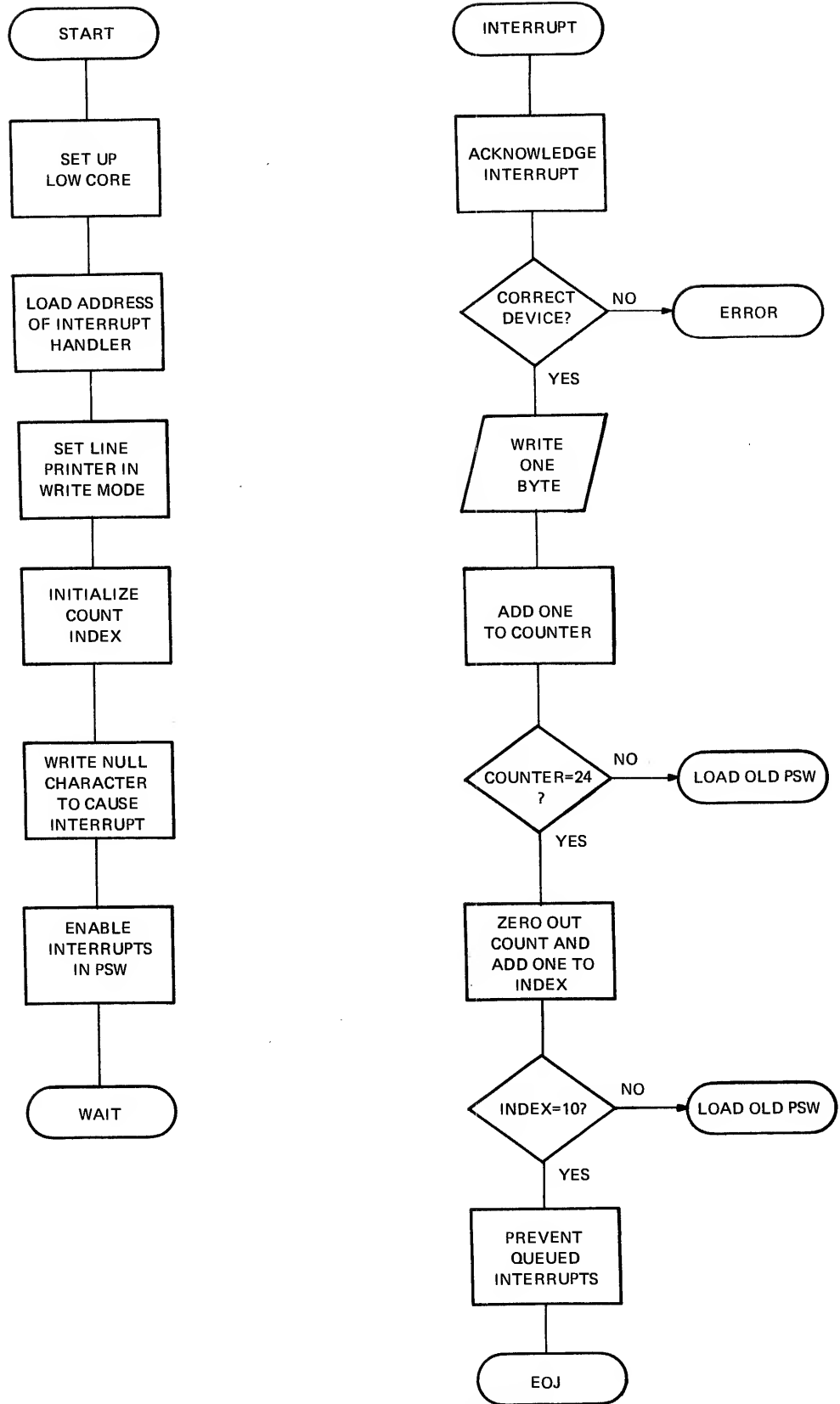
APPENDIX 2 (Continued)

APPENDIX 2 SENSE STATUS 16-BIT PROCESSORS
 ASSEMBLED BY CAL 03-066R05-00 (32-BIT)

START OPTIONS: *NONE*

	1 CAL ERROR	PREVIOUS ERROR ON PAGE	2
	NO CAL WARNINGS		
	2 PASSES		
ABSTOP	0000 0000		
ADC	0000 0002		
BSY	0000 0008	18*	31
BUFFER	0000 0034R	35	51*
DONE	0000 0024R	38	43*
DU	0000 0001	14*	30
FINAL	0000 0050R	45	55*
IMPTOP	0000 005CR		58
LADC	0000 0001		
LPADR	0000 004CR	22	53*
OC	0000 0008R	25*	30
PURETOP	0000 0000R		
R1	0000 0001	13*	22
R2	0000 0002	15*	23
R3	0000 0003	16*	29
R4	0000 0004	17*	24
SENSE	0000 000CR	29*	31
START	0000 0000R	22*	39
WAIT1	0000 0058R	55	57*
WRTCMD	0000 004ER	25	54*
			29
			35
			43
			47
			35
			36
			44
			25
			23
			24
			39
			37
			46
			46

APPENDIX 2 (Continued)



IMMEDIATE INTERRUPTS (16-BIT PROCESSORS)

APPENDIX 2 IMMEDIATE INTERRUPTS 16-BIT PROCESSORS
 PROG= LNPRTP ASSEMBLED BY CAL 03-066R05-00 (32-BIT)

```

1 1 SCRRAT
2 2 CROSS
3 3 TARGET 16
4 4 WIDTH 120
5 *
6 * THIS PROGRAM DEMONSTRATES OUTPUT TO THE LINE PRINTER UNDER
7 * INTERRUPT CONTROL ON A 16-BIT PROCESSOR
8 *
9 * THIS PROGRAM WRITES OUT A BUFFER 10 TIMES.
10 * THE BUFFER IS DEFINED AS * LINE PRINTER 2.2 TEST*
11 *
12 * SET UP REGISTERS
13 *
14 R1 EGU 1 DEVICE ADDRESS HOLD REGISTER
15 R2 EGU 2 WORK REGISTER
16 COUNT EQU 3 BUFFER COUNTER
17 INDEX EQU 4 LINE COUNTER
18 INT EQU 5 INTERRUPT DEVICE HOLD REGISTER
19 INTSTA EQU 6 INTERRUPT STATUS HOLD REGISTER
20 LH R1,DEVADR LOAD DEVICE ADDRESS
21 XHR R2,R2 ZERO OUT R2
22 *
23 * SET UP LOW CORE
24 *
25 STH R2,X*40* STORE ZERO IN OLD PSW
26 STH R2,X*42* STORE ZERO IN OLD LOC
27 STH R2,X*44* STORE ZERO IN NEW PSW
28 LHI R2,LPRINT
29 STH R2,X*46* STORE LINE PR INTRPT HANDLER
30 *
31 OC R1,WRTCMD IN NEW LOC
32 XHR COUNT,COUNT SET LP IN WRITE MODE
33 XHK INDEX,INDEX ZERO OUT COUNT
34 WDR R1,INDEX ZERO OUT INDEX
35 WAIT1 LPSW WAIT WRITE OUT NULL CHARACTER
36 *
37 * ACKNOWLEDGE INTERRUPT ROUTINE
38 *
39 LPINT AIR INT,INTSTA ACKNOWLEDGE INTERRUPT
40 CLHR INT,R1 TEST FOR CORRECT DEVICE
41 BNE DONE IF ERROR GO TO END OF JOB
42 *
43 * FILL UP OUTPUT BUFFER
44 *
45 WRITE WD R1,WRTBUF(COUNT) WRITE OUT ONE BYTE
46 AIS COUNT,1 INCREMENT COUNT
47 CLHI COUNT,24 IS COMPLETE BUFFER OUTPUT YET?
48 BE ZCOUNT YES, GO TO CHECK LINE COUNT
49 LPSW X*40* WAIT FOR ANOTHER INTERRUPT
50 ZCOUNT XHR COUNT,COUNT ZERO OUT COUNT
51 AIS INDEX,1 INCREMENT INDEX(LINE COUNTER)
52 CLHI INDEX,10 ARE 10 LINES OUTPUT YET
53 BNE DONE YES GO TO END OF JOB
    
```

```

APPENDIX 2 IMMEDIATE INTERRUPTS 16-BIT PROCESSORS      PAGE 2 06:21:11 08/25/78
004ER DE10 0058R      OC R1,DISARM      PREVENT QUEUED INTERRUPTS
0052K C200 0040      LPSW X'40'
54  *      *
55  *      *
56  *      *      DEFINE BUFFER AND OTHER CONSTANTS
57  *      *
58  *      *      WRITE MODE
59  WRTCMD DC X'4000'      DISARM MODE
60  DISARM DC X'C000'      DEVICE ADDRESS
61  DEVAJR DC X'62'
62  WRTBUF DC C' LINE PRINTER 2.2 TEST'
63  DC X'0D01'      CR AND SPACE ONE LINE
64  ALIGN 8      ENABLE EXT. INTERRUPTS AND WAIT
65  DC X'C000'
66  DC WAIT1
67  DC END
0056R 4000
0058R C000
005AK 0062
005CR 204C 494E 4520 5052
0064R 494E 5445 5220 322E
006CR 3220 5445 5354
0072R 0D01
0078K C000
0078R 0024R
007CR

```


APPENDIX 2 IMMEDIATE INTERRUPTS 16-BIT PROCESSORS

ASSEMBLED BY CAL 03-066R05-00 (32-BIT)

START OPTIONS: *NONE*

NO CAL ERRORS
NO CAL WARNINGS
2 PASSES

ABSTOP	0000 0000								
ADC	0000 0002								
COUNT	0000 0003								
DEVAUR	0000 005AR	16*	32	45	46	47	50	50	
DISARM	0000 0058R	20	61*						
DONE	0000 0052R	54	60*						
IMPTOP	0000 007CR	41	53						
INDEX	0000 0004								
INT	0000 0005	17*	33	34	51	52			
INTSTA	0000 0006	18*	39						
LADC	0000 0001	19*	39						
LPINT	0000 0028R	26	39*						
PURETOP	0000 0000R								
R1	0000 0001	14*	20	34	40	45	54	54	29
R2	0000 0002	15*	21	25	26	27	28	28	
WAIT	0000 0078R	35	65*						
WAIT1	0000 0024R	35*	66						
WRITE	0000 0030R	45*							
WRIBUF	0000 005CR	45	62*						
WRTCMD	0000 0056R	31	59*						
ZCOUNT	0000 0042R	46	50*						

APPENDIX 3
 LINE PRINTER PROGRAMMING
 EXAMPLES FOR 32-BIT PROCESSORS

APPENDIX 3 SENSE STATUS 32-BIT PROCESSORS

PROG= LNPRTR ASSEMBLED BY CAL 03-066R05-00 (32-BIT)

```

1 1 SCRAP
2 2 CROSS
3 3 WIDTH 120
4 4 TARGET 32
5 5 NORX3
6 *
7 * SAMPLE PROGRAM FOR LINE PRINTER ON A 32-BIT PROCESSOR
8 *
9 * THIS PROGRAM UTILIZES SENSE STATUS LOOPS TO WRITE OUT A BUFFER.10X.
10 * THE BUFFER IS DEFINED AS ' LINE PRINTER 3.1 TEST'
11 *
12 * SET UP REGISTERS
13 *
14 R1 EQU 1 DEVICE ADDRESS HOLD REGISTER
15 DU EQU 1 DEVICE UNAVAILABLE
16 R2 EQU 2 BUFFER LIMIT REGISTER
17 R3 EQU 3 STATUS HOLD REGISTER
18 R4 EQU 4 LINE COUNTER REGISTER
19 BSY EQU 8 BUSY
20 *
21 * LOAD DEVICE ADDRESS AND SET LINE PRINTER IN CORRECT MODE
22 *
23 START LH R1,LPADR LOAD DEVICE ADDRESS
24 XR R2,R2 ZERO OUT REGISTER 2
25 XR R4,R4 ZERO OUT REGISTER 4
26 OC R1,WRTCMD SET PRINTER IN WRITE MODE
27 *
28 * SENSE STATUS LOOP
29 *
30 SENSE SSR R1,R3 STATUS OF LINE PRINTER
31 BTBS DU,OC TEST FOR DEVICE UNAVAILABLE
32 BTBS BSY,SENSE TEST FOR BUSY STATUS
33 *
34 * FILL UP OUTPUT BUFFER
35 *
36 WD R1,BUFFER(R2) WRITE ONE BYTE FROM BUFFER
37 AIS R2,1 INCREMENT BUFFER
38 CLHI R2,24 IS BUFFER FILLED YET?
39 BE DONE YES, GO TO NEXT LINE
40 B SENSE NO, GO TO WRITE ANOTHER BYTE
41 *
42 * THIS ROUTINE COUNTS THE NUMBER OF LINES OUTPUT
43 *
44 DONE AIS R4,1 INCREMENT LINE COUNT
45 CLHI R4,10 ARE 10 LINES OUTPUT YET?
46 BE FINAL YES, GO TO END OF JOB
47 XR R2,R2 ZERO OUT REGISTER 2
48 B SENSE GO TO WRITE ANOTHER BYTE
49 *
50 * DEFINE BUFFER AND OTHER CONSTANTS
51 *
52 BUFFER DC C' LINE PRINTER 3.1 TEST'

```

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APPENDIX 3 SENSE STATUS 32-BIT PROCESSORS

000044I	3120	5445	5354							
000044I	0001				53	LPADR	DC	X'0D01'	OUTPUT CR AND SPACE 1 LINE	
00004CI	0062				54	WRTCMD	DC	X'62'	LINE PRINTER ADDRESS	
00004EI	8U				55	FINAL	DB	X'80'	WRITE	
000050I	C200	8004	=0000056I		56		LPSW	WAIT1		
**	B002	**			57		ALIGN			
000058I					58	WAIT1	DCY	8000		
000059I	0000	8000			59		DC	A(FINAL)	PUT PROCESSOR IN FINAL WAIT STATE	
C0005CI	0000	0050I			60			END		
000060I										

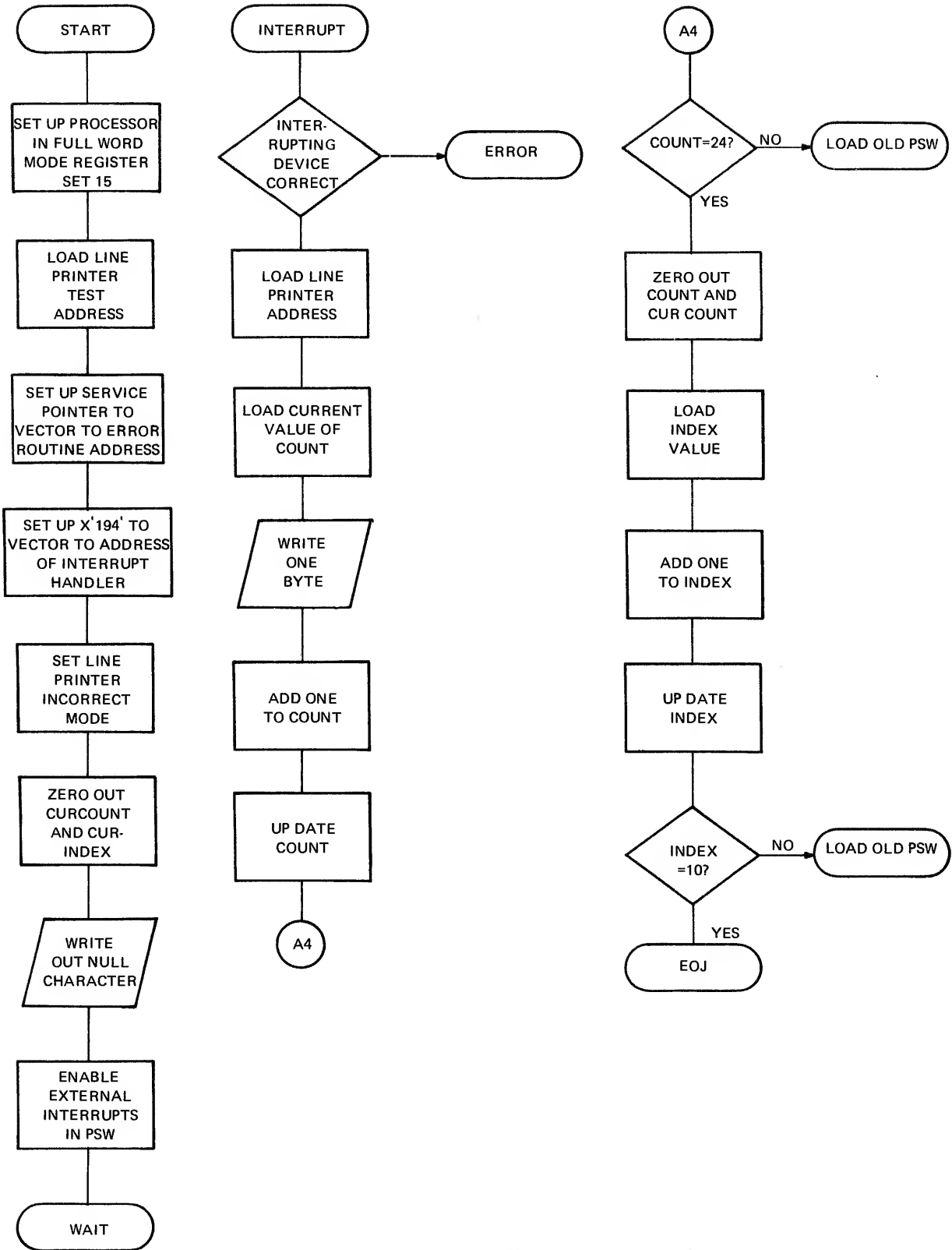
APPENDIX 3 SENSE STATUS 32-BIT PROCESSORS

ASSEMBLED BY CAL 03-066R05-00 (32-BIT)

START OPTIONS: *NONE*

1 CAL ERROR PREVIOUS ERROR ON PAGE 2
 NO CAL WARNINGS
 2 PASSES

ABSTOP	0000 0000					
ADC	0000 0004					
BSY	0000 0008	19*	32			
BUFFER	0000 0034I	36	52*			
DONE	0000 0024I	39	44*			
DU	0000 0001	15*	31			
FINAL	0000 0050I	46	56*			59
IMPTOP	0000 0060I					
LADC	0000 0002					
LPADR	0000 004CI	23	54*			
OC	0000 0008I	26*	31			
PURETOP	0000 0000P					
R1	0000 0001	14*	23	26	30	36
R2	0000 0002	16*	24	24	36	37
R3	0000 0003	17*	30	25	44	45
R4	0000 0004	18*	25	25	44	48
SENSE	0000 000CI	30*	32	40		
START	0000 0000I	23*				
WAIT1	0000 0058I	56	58*			
WRTCMD	0000 004EI	26	55*			



IMMEDIATE INTERRUPTS (32-BIT PROCESSORS)

APPENDIX 3 IMMEDIATE INTERRUPTS 32-BIT PROCESSORS
 PROG= LNPRTR ASSEMBLED BY CAL 03-066R05-00 (32-BIT)

```

1 SCRTAT
2 CROSS
3 NORX3
4 TARGET 32
5 WIDTH 120
6
7 * * THIS PROGRAM IS AN EXAMPLE OF IMMEDIATE INTERRUPTS ON A 32-BIT
8 * * PROCESSOR. THE PROGRAM OUTPUTS A BUFFER 10 TIMES.
9 * * THE BUFFER IS DEFINED AS ' LINE PRINTER 3.2 TEST'
10 *
11 * * SET UP REGISTERS
12 *
13 R0
14 R1
15 R2
16 R3
17 INDEX
18 COUNT
19 DEVADR
20 WORK
21 START
22
23
24 * * SET UP INTERRUPT SERVICE POINTER TABLE TO POINT TO ERROR ADDRESSES
25 * *
26 *
27 XR R2,R2
28 LHI R1,ERROR
29 STH R1,X'D0*(R2)
30 LDAGAIN AIS R2,2
31 CLHI R2,X'200'
32 BL LDAGAIN
33 * * SET UP INTERRUPT HANDLER OF LINE PRINTER IN DEVICE POINTER TABLE
34 * *
35 *
36 LH WORK,LNPRTR
37 SLLS WORK,1
38 LHI R2,INT
39 STH R2,X'D0*(WORK)
40 OC DEVADR,WRTCMD
41 XR COUNT,COUNT
42 STH COUNT,CURCOUNT
43 STH COUNT,CURINDEX
44 WDR DEVADR,COUNT
45 GOAGAIN LI R1,Y'CF0'
46 EPSR R0,R1
47 BS GOAGAIN
48 * * INTERRUPT HANDLER ROUTINE
49 * *
50 INT
51 LR R3,R3
52 BMZ ERROR
53 LH DEVADR,LNPRTR

```

0000 0000 WORK REGISTER
 0000 0001 ERROR ADDRESS HOLD REGISTER
 0000 0002 STATUS HOLD REGISTER
 0000 0003 BUFFER LIMIT HOLD REGISTER
 0000 0004 LINT COUNT REGISTER
 0000 0005 DEVICE ADDRESS REGISTER
 0000 0006 WORK REGISTER
 0000 0007 REGISTER SET 15
 C800 00F0 LOAD DEVICE ADDRESS
 9510 EPSR R0,R0
 4860 809A =0000A4I LH DEVADR,LNPRTR

 0722 XR R2,R2
 C810 0082I LHI R1,ERROR
 4012 0000 STH R1,X'D0*(R2)
 2622 LDAGAIN AIS R2,2
 C520 0200 CLHI R2,X'200'
 4280 FFF2 =000010I BL LDAGAIN

 4870 8082 =0000A4I LH WORK,LNPRTR
 1171 0046I SLLS WORK,1
 C820 0000 LHI R2,INT
 4027 0000 STH R2,X'D0*(WORK)
 DE60 8072 =0000A2I OC DEVADR,WRTCMD
 0755 XR COUNT,COUNT
 4050 8050 =000086I STH COUNT,CURCOUNT
 4050 804E =000088I STH COUNT,CURINDEX
 9A65 WDR DEVADR,COUNT
 F810 0000 C0F0 GOAGAIN LI R1,Y'CF0'
 9501 EPSR R0,R1
 2204 BS GOAGAIN

 0833 LR R3,R3
 4230 8036 =000082I BMZ ERROR
 4860 8054 =0000A4I LH DEVADR,LNPRTR

```

000050I 4650 8032 =000086I          LH COUNT,CURCOUNT      INITIALIZE COUNT
000054I DA65 8032 =00008AI          WD  DEVADR,WRTBUF(COUNT) WRITE OUT ONE BYTE OF BUFFER
54 * * ADD ONE BYTE TO BUFFER
55 * *
56 * *
57 * *
58 * *
59 * *
60 * * AIS COUNT,1          INCREMENT COUNT
61 * * STH COUNT,CURCOUNT  UPDATE CURCOUNT
62 * * CLHI COUNT,24        IS COMPLETE BUFFER OUTPUT YET
63 * * BE ZCOUNT          YES GO TO LINE COUNT
64 * * LPSWR R0            LOAD OLD PSW
65 * *
66 * * COUNTER FOR OUTPUT OF 10 LINES
67 * * ZCOUNT          COUNT,COUNT      ZERO OUT COUNT
68 * * XR STH           COUNT,CURCOUNT  INITIALIZE CURCOUNT
69 * * LH INDEX,CURINDEX  INITIALIZE INDEX REGISTER
70 * * AIS INDEX,1        INCREMENT INDEX(LINE COUNTER)
71 * * STH! INDEX,CURINDEX  UPDATE INDEX
72 * * CLHI INDEX,10     ARE TEN LINE OUTPUT YET?
73 * * BE DONE           YES GO TO EOJ
74 * * LPSWR R0         LOAD OLD PSW
75 * * EQU *            ERROR
76 * * B START          B START
77 * * CURCOUNT DC X'0'  CURCOUNT DC X'0'
78 * * CURINDEX DC X'0'  CURINDEX DC X'0'
79 * * WRTBUF DC C' LINE PRINTER 3.2 TEST'
80 * * DC X'0001'        CR AND SPACE ONE LINE
81 * * WRTCMD DC X'4000'  WRITE MODE
82 * * LNPRT DC X'62'   LINE PRINTER ADDRESS
83 * * DGRF LPSW WAIT
84 * * ALIGN 8
85 * * DC Y'8000'
86 * * DC A(DONE)
87 * * END

```

APPENDIX 3 (Continued)

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APPENDIX 3 IMMEDIATE INTERRUPTS 32-BIT PROCESSORS

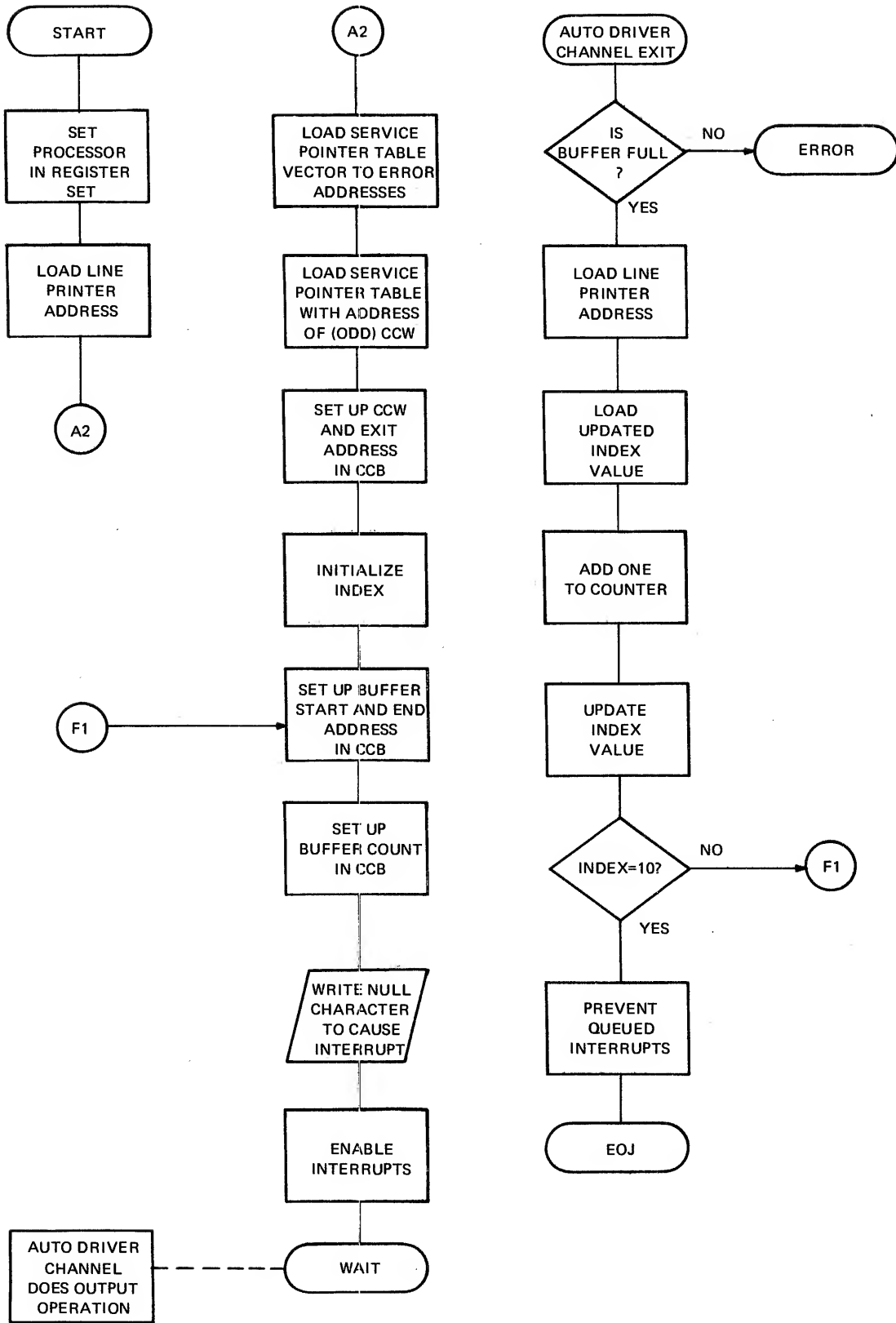
ASSEMBLED BY CAL 03-066R05-00 (32-BIT)

START OPTIONS: *NONE*

NO CAL ERRORS
NO CAL WARNINGS
2 PASSES

	18*	41	41	42	43	44	54	55	59	60	61	67	67
ABSTOP	0000 0000												
ADC	0000 0004												
COUNT	0000 0005												
CURCOUNT	0000 0066I												
CURINDEX	0000 0088I	54	60	68	77*								
DEVADR	0000 0006	69	71	78*	53	55							
DONE	0000 00A6I	19*	40	44									
ERROR	0000 0082I	73	86										
GOAGAIN	0000 003CI	28	75*										
IMPTOP	0000 00B8I	45*											
INDEX	0000 0004		70	71	72								
INT	0000 0046I	17*	69										
LADC	0000 0002	38	51*										
LDAGAIN	0000 0010I	29*											
LNPR	0000 00A4I	23	36	82*									
PURETOP	0000 0000P		53										
R0	0000 0000	13*	21	46	63	74							
R1	0000 0001	14*	22	29	45	46							
R2	0000 0002	15*	27	29	30	31	36	39					
R3	0000 0003	16*	51										
START	0000 0000I	21*	76										
WAIT	0000 00B0I	83	85*	39									
WORK	0000 0007	20*	36										
WRIBUF	0000 00A1I	55	79*										
WRTCMD	0000 00A2I	40	81*										
ZCOUNT	0000 0068I	62	67*										

APPENDIX 3 (Continued)



AUTO DRIVER CHANNEL (32-BIT PROCESSORS)

APPENDIX 3 AUTO DRIVER CHANNEL 32-BIT PROCESSORS
 PROG= LMPRT ASSEMBLED BY CAL 03-066R05-00 (32-BIT)

```

1  SCRAP
2  CROSS
3  NORX3
4  TARGET 32
5  WIDTH 120
6  *
7  * THIS PROGRAM DEMONSTRATES THE LINE PRINTER UNDER AUTO-DRIVER
8  * CHANNEL CONTROL TO OUTPUT A BUFFER OF 24 CHARACTERS 10 TIMES
9  * THE BUFFER IS DEFINED AS ' LINE PRINTER 3.3 TEST'
10 *
11 * SET UP REGISTERS
12 *
13 R0 EQU 0 WORK REGISTER
14 R1 EQU 1 WORK REGISTER
15 STAT EQU 2 STATUS REGISTER
16 DEVADR EQU 2 DEVICE ADDRESS REGISTER
17 R6 EQU 6 WORK REGISTER
18 R7 EQU 7 WORK REGISTER
19 R8 EQU 8 ERROR ADDRESS REGISTER
20 R9 EQU 9 INCREMENT COUNTER REGISTER
21 R10 EQU 10 NULL CHARACTER REGISTER
22 R15 EQU 15 LINE COUNTER REGISTER
23 *
24 * SET UP PROCESSOR IN REG SET 15
25 *
26 LI R0,Y'00F0' REG SET 15
27 EPSR SET PSW
28 XR R10,R10 ZERO OUT REG 10
29 START1 LH DEVADR,LPADR LOAD DEVICE ADDRESS
30 LHI R0,CCW+1 LOAD ODD CHAN. CON.WORD ADDRESS
31 *
32 * SET UP SERVICE POINTER TABLE TO VECTOR TO ERROR ADDRESSES
33 *
34 XR R9,R9 ZERO OUT REG 9
35 LHI R8,ERROR LOAD ERROR ROUTINE ADDRESS
36 LDAGAIN STH R8,X'D0'(R9) STORE ERROR ROUT ADR IN TOP OF TABLE
37 AIS R9,2 INCREMENT COUNTER
38 CLHI R9,X'200' IS TABLE FULL YET
39 BL LDAGAIN NO.LOAD ANOTHER
40 *
41 * SET UP LINE PRINTER ADR IN TABLE
42 *
43 LH R7,LPADR LOAD LP ADDRESS
44 SLLS R7,1 MULTIPLY BY 2
45 STH R0,X'D0'(R7) STORE IN TABLE
46 *
47 * SET UP CHANNEL COMMAND BLOCK
48 *
49 LA R7,FINISH LOAD SUBROUTINE ADDRESS
50 STH R7,SUBADR STORE IN CCB
51 LHI R7,X'2505' STATUS MASK FAST WRITE
52 STH R7,CCW STORE IN CCB
53 XR R15,R15 ZERO OUT REGISTER 15
    
```

APPENDIX 3 AUTO DRIVER CHANNEL 32-BIT PROCESSORS PAGE 2 06:19:23 04/25/78

```

000042I 40F0 804E =000094I
000046I DE20 8050 =00009AI
00004AI E660 804E =00009CI
00004EI E670 8061 =0000B3I
000052I 5070 8066 =0000BCI
000056I 0B67
000058I 4060 805E =0000BAI
00005CI 08AA
00005EI 2132
000060I 9A2A
000062I F810 0000 C0F0
000068I 9501
00006AI 4300 FFDC =00004AI

00006EI 4320 801E =000090I
000072I 4820 8020 =000096I

000076I 48F0 801A =000094I
00007AI 26F1
00007CI 40F0 8014 =000094I
000080I C5F0 000A
000084I 4280 FFC2 =00004AI
000088I DE20 800C =000098I
00008CI 4300 803E =0000CEI
000090I 0000 0090I
000094I 4300 FF76 =00000AI
000096I 0000
000098I 0062
00009AI 4000
00009CI 204C 494E 4520 5052
0000A4I 494E 5445 5220 332E
0000ACI 3320 5445 5354
0000B2I 0D01
0000B6I 0000 00B3I

000086I
000088I 0000
00008AI 0000
00008CI 0000 0000
0000C0I 0000
0000C2I 0000
0000C4I 0000 0000
0000C8I 0000 0000
0000CCI 0000
0000CEI C200 8006 =000008I
00008I

54 STH R15,INDEX INITIALIZE INDEX
55 OC DEVADR,WRTCMD SET LINE PRINTER IN WRITE MODE
56 REPEAT LA R6,WRTBUFS LOAD WRITE BUFFER STARTING ADDRESS
57 LA R7,WRTBUFE LOAD WRITE BUFFER ENDING ADDRESS
58 ST R7,BUFEND STORE END ADDRESS IN CCB
59 SR R6,R7 COMPUTE BUFFER SIZE
60 STH R6,BUFCOUNT STORE BUFFER SIZE IN CCB
61 LR R10,R10 SET CONDITION CODE
62 BNZS SKIP IF 0 SEND WDR COMMAND
63 WDR DEVADR,R10 WRITE A NULL CHARACTER
64 SKIP LI R1,Y'COF0, SET REG SET 15
65 EPRS R0,R1
66 B REPEAT
67 *
68 * AUTO DRIVER CHANNEL EXIT
69 *
70 FINISH BFC STAT,ERROR TEST FOR BAD STATUS
71 LH DEVADR,LPADR LOAD DEVICE ADDRESS
72 *
73 * COUNTER FOR 10 LINES OF OUTPUT
74 *
75 LH R15,INDEX INITIALIZE INDEX
76 AIS R15,1 INCREMENT COUNTER
77 STH R15,INDEX UPDATE INDEX
78 CLHI R15,10 ARE 10 LINES OUTPUT YET?
79 BL REPEAT NO OUTPUT ANOTHER
80 OC DEVADR,DISARM PREVENT QUEUED INTERRUPTS
81 B WAITI GO TO E0J
82 ERROR EQU *
83 B START1
84 INDEX DC X'0,
85 LPADR DC X'62,
86 DISARM DC X'C000,
87 WRTCMD DC X'4000,
88 WRTBUFS DC C' LINE PRINTER 3.3 TEST,

89 DC X'0D01,
90 WRTBUFE EQU *-1
91 ALIGN 8
92 *
93 * STORAGE FOR ENTIRE CHANNEL COMMAND BLOCK
94 * NOTE: FOR EASE OF READING EACH SECTION OF BLOCK
95 * DEFINED EXPLICITLY WHETHER USED OR NOT USED
96 *
97 CCM DC H'0, * CHANNEL COMMAND WORD
98 BUFCOUNT DC H'0, * BUFFER COUNT
99 BUFEND DC F'0, * END ADDRESS OF BUFFER
100 CHECK DC H'0, * CHECK
101 BUFCINT DC H'0, * BUFFER ONE COUNT
102 BUFIEND DC F'0, * BUFFER ONE END ADDRESS
103 TABLE DC F'0, * TABLE
104 SUBADR DC H'0, * SUBROUTINE ADDRESS
105 WAITI LPSW WAIT
106 ALIGN 8

```

APPENDIX 3 AUTO DRIVER CHANNEL 32-BIT PROCESSORS

0000D8I	0000 8000	107	WAIT	DC	Y*8000*
0000DCI	0000 00D8I	108		DC	A(WAIT)
0000E0I		109		END	

PUT PROCESSOR IN WAIT STATE

APPENDIX 3 (Continued)

ASSEMBLED BY CAL 03-066R05-00 (32-BIT)

START OPTIONS: *NONE*

NO CAL ERRORS
NO CAL WARNINGS
2 PASSES

ABSTOP	0000	0000							
AOC	0000	0004							
BUFICNT	0000	00C2I	101*						
BUFICNT	0000	00C4I	102*						
BUFCOUNT	0000	008AI	60	98*					
BUFEND	0000	00BCI	58	99*					
CCW	0000	0038I	30	52					
CHECK	0000	00C0I	100*				97*		
DEVADR	0000	0002	16*	29	55	63	71	80	
DISARM	0000	0098I	80	86*					
ERROR	0000	0090I	35	70	82*				
FINISH	0000	006EI	49	70*					
IMPTUP	0000	00E0I							
INDEX	0000	0094I	54	75	77	84*			
LADC	0000	0002							
LDAGAIN	0000	0018I	36*	39					
LPADR	0000	0096I	29	43	71	85*			
PURETOP	0000	0000P							
R0	0000	0000	13*	26	27	30	45	65	
R1	0000	0001	14*	27	64	65			
R10	0000	000A	21*	28	28	61	61	63	
R15	0000	000F	22*	53	53	54	75	76	78
R6	0000	0006	17*	56	59	60			
R7	0000	0007	18*	43	44	45	49	50	51
R8	0000	0008	19*	35	36				52
R9	0000	0009	20*	34	34				57
REPEAT	0000	004AI	56*	66	66	79	37	38	
SKIP	0000	0062I	62	64*					
STARTI	0000	000AI	29*	83					
STAT	0000	0002	15*	70					
SUBADR	0000	00CCI	50	104*					
TABLE	0000	00C8I	103*						
WAIT	0000	00D8I	105	107*					58
WAITI	0000	00CEI	81	105*					59
WRIBUFE	0000	0093I	57	90*					
WRIBUFS	0000	009CI	56	88*					
WRICMD	0000	009AI	55	87*					

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